Does Filter-Drier Size Really Matter?

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I should probably rephrase the question to read, *"Is size more important than desiccant type?"*

While the volume of a drier directly relates to capacity, the type of desiccant material used is also a very important consideration. The physical adsorption mechanism, which is responsible for removing contaminates from the refrigerant, occurs *on the surface* of the adsorbent material and not inside the adsorbent material. To state it another way, the more surface area, the more sites for the physical adsorption of water and/or acid.

Note that I said the more surface area, not volume. Imagine the drier material as small spheres, if they were exactly spheres you would maximize the surface area per unit volume by having many small spheres instead of fewer larger spheres in the same drier volume. Unfortunately, many tiny spheres would pack very tightly and lead to tremendous pressure drops, so alternative means of increasing the surface are needed.

One approach you could visualize are irregular surfaces with many peaks and valleys. Anyone who has ever hiked knows that peaks and valleys add much greater distance to your destination, rather than simply traveling along level ground. Clearly, a surface with numerous peaks and valleys has significantly more surface area, compared to a flat or smooth surface.

Now let's turn to some specifics related to refrigerant driers. Activated Alumna, a low cost and somewhat common desiccant, has an average surface area to mass ratio (the surface area of a particle divided by the mass of the particle) of 300 square meters of surface area per gram of material. Wow, think about that again, 300 square meters or 3,236 square feet (the area of a large house) per gram!

While this may seem large, compare it to Molecular Sieve materials, which have an average surface area to mass of 900 square meters of surface area or 9,708 square feet (the area of a mansion) per gram of material! That is, Molecular Sieves have three times the adsorption surface area of Activated Alumna for the same mass of material. Since contaminates are physically captured on these surfaces, it should become clear why Molecular Sieves have a greater storage area per unit mass.

But driers are not sold by mass, but rather by volume, and refrigeration service mechanics compare driers not on a mass basis but on a volume basis ("I need an eight-cubic-inch drier!"). Therefore, we need to use the density of the various drier materials (density is the ratio of mass per unit volume) to convert these drier comparisons from a per-mass basis to a per-volume basis. Since the densities of Molecular Sieves and Activated Alumina are not too different, the comparison by volume is not far from the comparison by mass.

Comparing drier capacity in terms of equal volumes of materials, we find that **Molecular Sieves have 2.8 times the adsorption surface area of Activated Alumna.** Clearly, as a rule of thumb, Molecular Sieves provide about three times the capacity of Activated Alumna driers on either a mass or volume basis.

Thus a 9 cubic inch filter drier that uses 100% Molecular Sieve material is as good as a 25 cubic inch filter drier that uses 100% Activated Alumina. So look as what your buying! **Compare filter driers in terms of their moisture carrying capacity not their size.**

Finally, I need to point out that typical driers are a combination of one or more drier (desiccant) materials. Even driers touted as "Molecular Sieve Driers" are typically not 100% molecular sieve material, since blends of desiccants provide better overall removal of organic particles, paraffin, acids, and water. There are also different types of molecular sieves, such as 3A, 4A, 5A, and so on, where the number-letter designation refers to the pore size in angstroms (a very small unit of measure). There are also loose filled driers, where loose particles are constrained it the filter-drier by filter screens and a spring and solid core filter-driers where the desiccant material is sintered into a single porous core. Both packaging methods affect the surface area available for adsorption of water and acid.

Compare filter-driers on their moisture capture capacity, not their size or weight.

Big is not always better.